Alternative Renewable Energy Sources Program

report to the

montana legislature

january 1979

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ENERGY DIVISION

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

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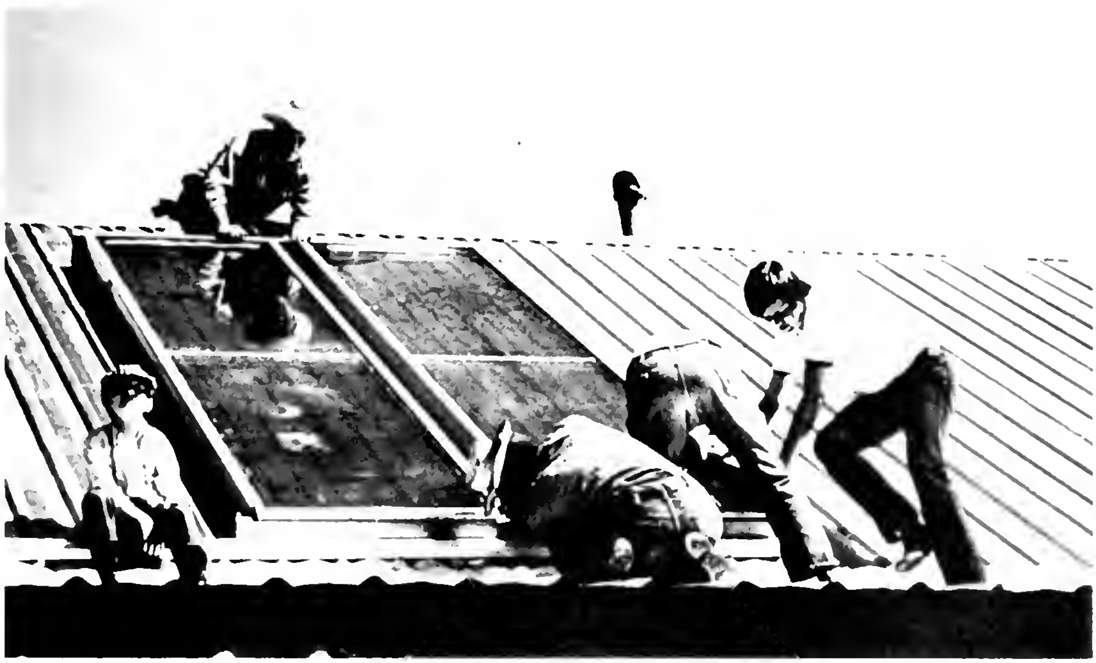

Few ideas have captured the imagination of the American people more than the development of renewable energy sources. Many policy analysts share this enthusiasm because of the potential contribution these sources offer to satisfy future energy needs.

—The Council of State Government

ACKNOWLEDGMENTS

This report was prepared by staff of the Conservation and Renewable Resources Bureau; R. Kitty Kvinge coordinated the overall activity involved.

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All photographs (except as noted) were taken by Mark Radosevich.

INTRODUCTION

Renewable energy is nothing new to Montana. Until 1975, falling water generated most of the electricity consumed within this state.[1] Wind electric systems were prevalent in eastern Montana prior to the growth of rural electric cooperatives. Historically, renewable energy has been shown to work in Montana, but no historical data exists specifying the degree to which renewable energy can be effectively and systematically harnessed to meet the energy requirements of our advanced industrial society. Although existing evidence suggests that renewable energy can be an important element of our over all energy supply system, this supposition must first be verified.

When the Montana Legislature passed Senate Bill 86 establishing the Montana Alternative Renewable Energy Sources Program in 1975, it mandated that the program seek ways to lessen Montana's reliance on nonrenewable energy sources. Every project funded by the program has sought to decrease reliance on conventional fuels by either: generating such needed information as solar insolation data; demonstrating the workability of different energy forms by installation of individual renewable energy systems; or developing new approaches for more effective use of the renewable energy sources in Montana. Because the program's projects have enhanced the understanding of renewable energy, they are the necessary first step toward more wide-spread use of renewable energy technology in this state.

Funding for these projects is provided through grants, using revenue derived from a nonrenewable energy source—coal. Until 1980, the program will receive approximately 1.9 percent of the coal severance tax not held in trust; after 1980, the program will receive 2.5 percent.

The following report begins with a history of the program and the function of those involved with the reviewing and granting of renewable energy projects. The next two chapters provide a discussion of the grants awarded to date and the operational procedures of the program. A brief overview of program activity with the renewable energy sources follows. The next chapter outlines the methods used to provide information to the public. The final chapter is a summary and evaluation of the program. It focuses on the mandate of the law and critiques how well the program has met that directive.

[1] Itami, Rick, *Montana Historical Energy Statistics*, Montana Energy Office, February, 1978

PROGRAM DIRECTION AND ADMINISTRATION

The purposes of this act are to stimulate research, development, and demonstration of energy sources which are harmonious with ecological stability by virtue of being renewable, thereby to lessen that reliance on nonrenewable energy sources which conflicts with the goal of long-range ecological stability . . .

—Section 84-7407, R.C.M. 1947

PROGRAM DIRECTION

The program has attempted to stimulate research, development and demonstration of renewable energy sources by funding the most promising renewable energy proposals submitted. Each project supported was designed to either:

1. research the various energy sources to determine the best means of using renewable energy under Montana's conditions;
2. develop new approaches to more effectively use renewable energy resources within Montana; or
3. demonstrate the technology to make renewable energy more useful and thereby develop public awareness and acceptance.

The afternoon sun reflects off the window of this passively-heated home in Bozeman. The long vertical columns just inside the window are filled with water which is heated during the day by the sun. The heat stored in these tubes can warm the house for a 2 to 3-day period.

PROGRAM ADMINISTRATION

The Alternative Renewable Energy Sources Program, administered by the Energy Division of the Montana Department of Natural Resources and Conservation, is integrated with Division work on other energy matters. The daily operations of the program are managed by the staff of the Conservation and Renewable Resources Bureau, including: the Bureau Chief, two staff engineers, an administrative assistant and a secretary. The Bureau Chief is responsible for the overall operation of the program, reviewing and evaluating all projects and establishing new areas of program emphasis. The staff engineers provide technical assistance for grant reviews, evaluate projects, monitor contracts, conduct on-site reviews of funded projects and offer public assistance. The administrative assistant answers public inquiries about the program, assists with administrative details, and provides reports, publications and updated information on program activities. The secretary maintains contract files, assists with processing grant materials and enters data into a computerized contract management system.

The purpose of the program is to fund renewable energy projects; therefore, one of the aims of the Department is to hold administrative expenses below 15 percent of total program costs. To date, the cost of administering the program has not exceeded 10 percent (Appendix A).

An artesian well in the St. Ignatius area assists in year-around heating and humidifying of a solar greenhouse. The warm water is also being used with a heat pump for space heating the owner's home.

GUIDELINES AND PROCEDURES FOR FUNDING

The operational procedures for funding renewable energy projects were formed by the Department after consultation with the sponsors of the legislation. A procedural flow chart is given in Figure 1. The resulting rules which provide the criteria and guidelines for funding are oriented toward small-scale applications and are intended to keep all resulting technology within the reach of the average Montana citizen (Appendix E).

GUIDELINES

In order to obtain funding from the program for a renewable energy project, certain criteria must be met. Grantees must be Montana residents, and projects must be conducted in Montana and applicable to this state's energy needs. Although there is no minimum or maximum allowable request, applications for more than $100,000 are discouraged. Most grants awarded have been for $2,000 to $15,000. This is because it has been the philosophy of the Department to support smaller scale innovations.

Among the items considered inappropriate for funding are: previously completed projects; excessive users of energy such as home air conditioners and private swimming pools; and basic energy conservation measures such as insulation and weatherstripping. Furthermore, the law specifically forbids using grant funds to develop facilities which market electricity, heat energy or energy by-products. However, funding may be used to establish facilities which manufacture equipment for renewable energy systems in Montana, providing that all or part of the grant funds are returned when such facilities show profit or stability.

PROCEDURES

If the above criteria have been met, applications then go through a competitive screening process. Applicants are asked to follow a format outlined under the "general requirements" section of the rules and regulations. Proposals should contain sufficiently complete and accurate technical, business and budget information to allow a substantive evaluation of the proposed project. If an application conforms to the rules and regulations, the proposal is accepted for review. If it does not, more information is requested or the proposal is returned to the applicant with an explanation of deficiencies. The applicant can then make corrections and resubmit the application during a subsequent grant period.

Once the screening has been made, the program staff considers the technical feasibility of the project. Will the system work? Are all the calculations correct? And most importantly, does the applicant have the necessary ability to undertake the proposed project? If not, the applicant may be encouraged to seek a project consultant with the necessary technical knowledge and background.

Technical problems are noted and the proposal undergoes the next review.

This review is made by the Department and the Alternative Energy Advisory Council, a group of five Montana citizens appointed by the Department. At this time, each project's potential for practical application and development in Montana is evaluated. The project's merits, its value to Montana citizens and its conformity to the program goals are considered.

The combined recommendations of the staff and the Council are then submitted to the Department Director who reviews each proposal, considers the recommendations and makes the final decision on grant awards. If a proposal passes through the review process and is approved by the Director, a contract is signed between the Department and the grantee, and the project begins.

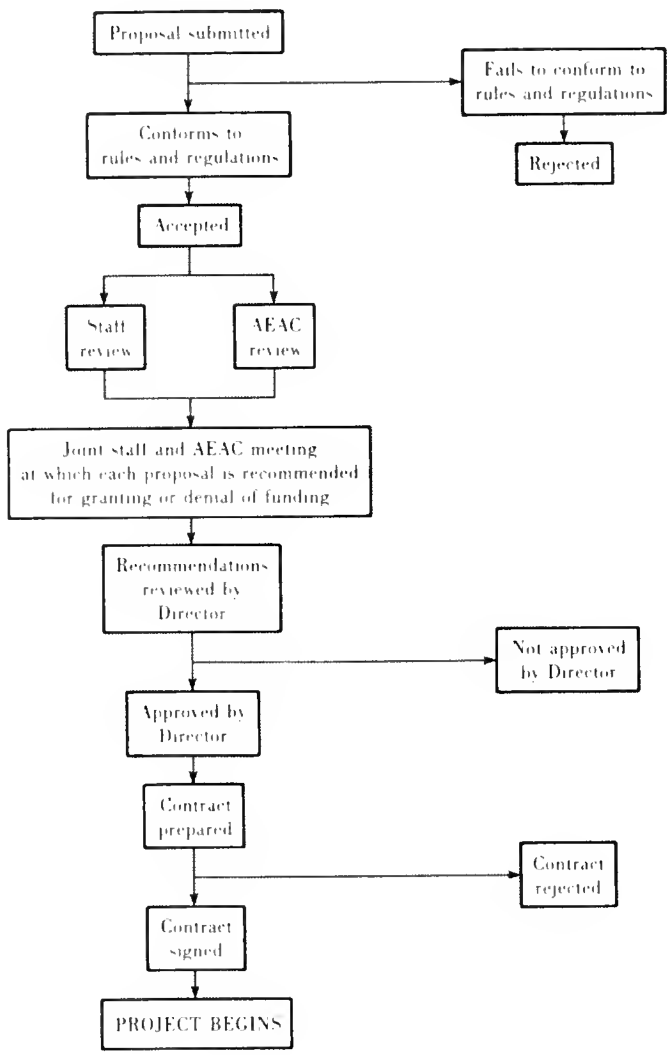


FIGURE 1. PROCEDURAL FLOW CHART

PROJECTS FUNDED

Each project funded by the Department falls into one of the following renewable energy categories: biomass, geothermal, small-scale hydro, solar, wind and wood. In addition to focusing on these energy forms, educational and technical assistance projects have been supported.

Solar projects have attracted the largest number of applications (287) and have received the greatest amount of grant funding ($897,892). However, many of the projects designated "solar" include integrated systems which involve the use of other renewable energy sources. These integration projects were placed in the solar category since the use of that energy form encompassed the largest portion of the project. The broad definition of a solar project involves a variety of activities such as developing solar collection devices, measuring solar radiation, studying heat storage technology, and assessing system and collector performance. Applications which involve all other renewable energy forms (130) number less than half those received for solar projects, yet this group has received approximately the same amount of total funding ($830,541).

Figure 2 shows the yearly percentages of funding in each resource category per grant period; tables B-1 through B-4 (Appendix B) present the amounts of funds requested and awarded in each grant period. These figures do not include any matching funds. Such matching funds nearly equal the total amount of money granted by the program. For purposes of administration the state was divided into ten areas. The geographical distribution of projects is shown in Figure C-1 (Appendix C).

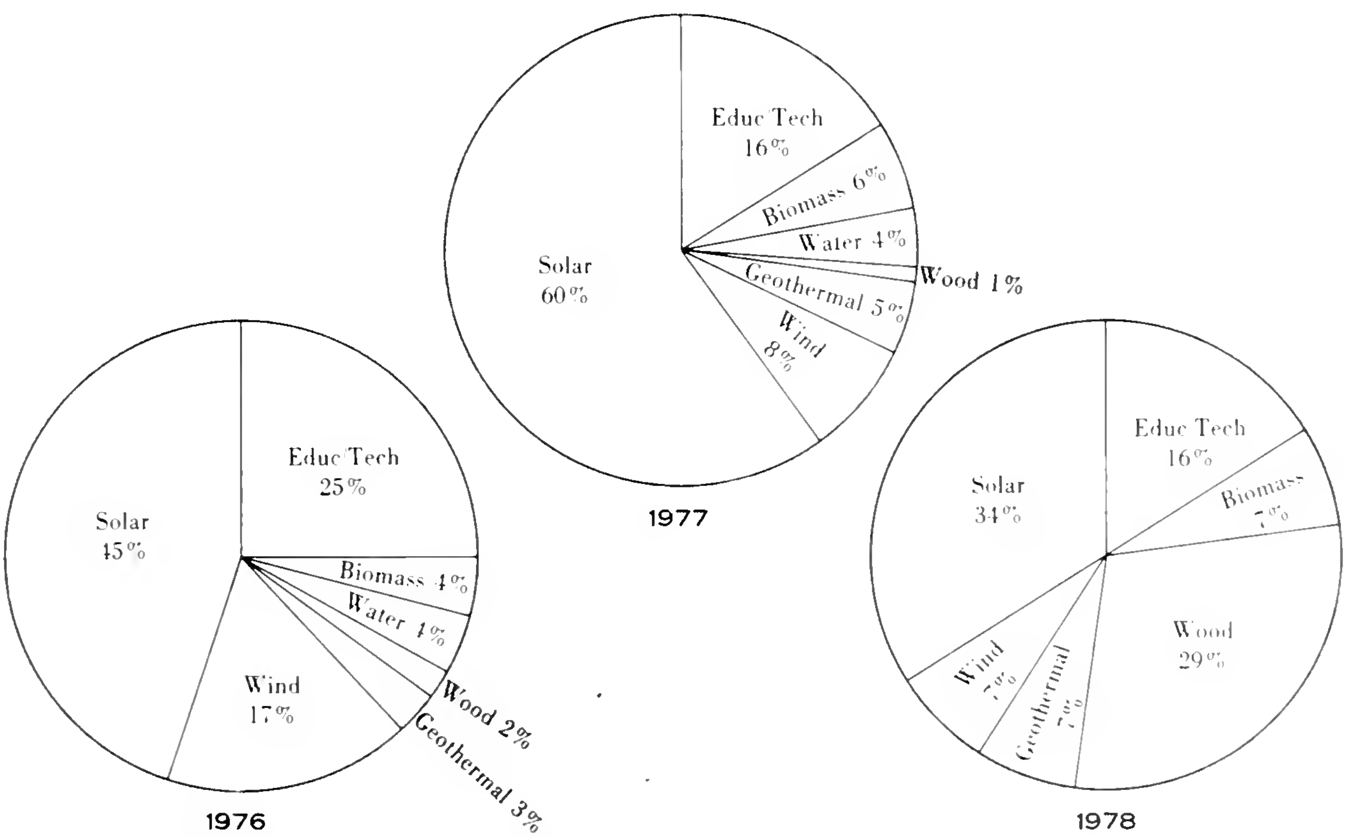


FIGURE 2. YEARLY PERCENTAGE OF FUNDING BY CATEGORY

THE PROGRAM AND THE PROJECTS

Each project funded by the Department falls into one of the renewable energy categories discussed in this section. Support was based on how well the project conformed to the program's objectives of research, development and demonstration of the energy source. Following is an overview of what has been accomplished through the program. In some instances, a highlight of a project is presented to give the reader an idea of the general scope of the activity.

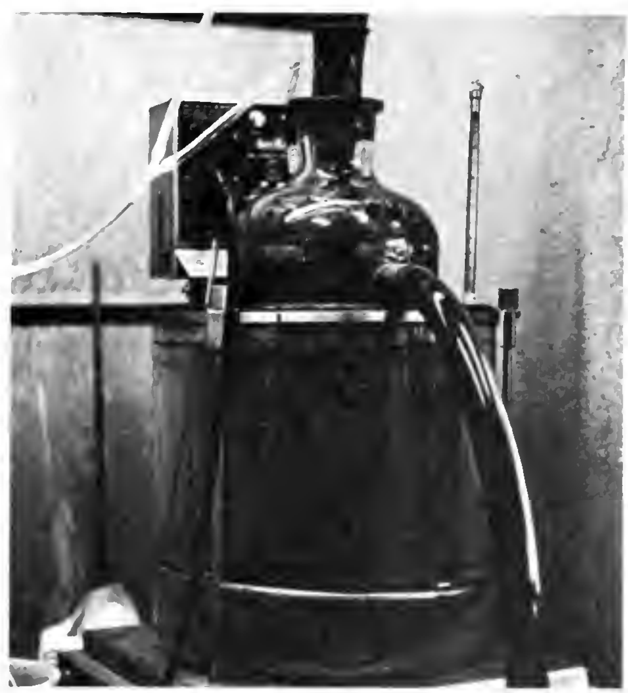
BIOMASS

Biomass is an inclusive term generally referring to such organic material as animal waste, sewage, and agricultural crops and crop residue. Wood fiber is similarly a biomass material, but to simplify discussion, it is treated separately in this report. The benefits of converting biomass to fuel and other products are two-fold:

1. the production of usable energy (methane, ethanol or heat from combustion of the material itself) plus valuable by-products;
2. the reduction of environmental problems through the productive use of waste materials.

The biomass energy resource of Montana is now beginning to receive much deserved attention. To date, nineteen proposals for projects in this area have been received and six of these have been funded totalling $129,261. Two of these projects will use animal or plant waste for home heating needs; one project uses a composting digester to heat a greenhouse and the other involves an owner-designed system using a heat pump and animal waste composter for space heating.

The remaining four projects are examining the biomass production process in an attempt to reduce the amount of time needed to convert organic waste to useable fuel. Three of these research projects have produced information which indicates that the bioconversion process can be influenced to increase the methane output. If further breakthroughs are achieved, fuel production from animal and plant waste could become economically practical.



This laboratory-sized digestor and testing system located in the Chemistry Department at MSU, uses a mixture of animal and plant waste to produce methane gas. Results of the research indicate that methane output can be substantially increased. This and related work will be used to design a pilot methane digestor for a Montana farm.

Photo Courtesy Dana Gunderson

Beyond these efforts, the program is supporting work which deals with another type of agricultural biomass—crops and crop residues. The program currently has research work underway concerning the use of crops and crop residues in the production of such energy forms as ethanol. This work has focused, in part, on the production of gasohol, a mixture of ethanol and gasoline, in an attempt to analyze its potential in Montana.

GEOTHERMAL

The Rocky Mountain Indians once considered steaming, bubbling geothermal springs as evil spirits—not only because they stayed warm all winter, defying snow and ice, but also because of their sulfurous odor and clouds of steam. Later, enterprising settlers erected resorts near these springs and advertised the mineral baths as healing cures for many ailments.

Today, the energy potential of the numerous hot springs scattered across the state is being explored. Thus far, the program has received fifteen proposals for geothermal development and has supported six of those projects, resulting in a total funding of $83,765. All of the funded projects have emphasized resource assessment and sought better ways to tap and effectively use geothermal energy; half of them include development of the resource as part of the project. The projects range in scope from a single dwelling application of geothermal heat to preliminary work on using the resource for heating large buildings.

This 2-bedroom house, located just outside of Helena, receives 100 percent of its heating needs from a geothermal well. The home used Broadwater Hot Springs as its geothermal source and is serving as a test model for future development. At right, hot water, piped into the home and through a series of heat exchangers, supplies enough heat for both domestic hot water and home heating needs.

The results from one of these resource assessment and development projects may eventually serve as the basis for a geothermal energy development affecting an entire community. This project, located in White Sulphur Springs, began with

resource assessment by drilling a test well to determine the nature and extent of the geothermal resource. The well is now used for delivering hot water to provide space heating in a new commercial building. This is accomplished by using heat exchangers to transfer heat from the geothermal water to the forced-air heating system of the building.

The state's initiation of this project led to the coordination of drilling and testing with a firm that performs tests for many federal geothermal projects. The resulting temperature and strata profile logs provide the detail needed to estimate the potential for broader geothermal development. The federally funded assistance of this firm and the experience gained by actually using the resource, will lead to a better understanding of the technique needed to appropriately develop and use geothermal energy.

SMALL-SCALE HYDROPOWER

The majority of this country's large, easy-to-develop hydroelectric sites have already been developed. Yet there are numerous untapped small streams and waterfalls in Montana which are well suited for small-scale hydroelectric development. The rate of flow of water multiplied by the pressure exerted as the water falls (referred to as the head) is the key to determining a river, stream or creek's hydroelectric power potential. Thus a small stream with a high head may furnish as much power as a large stream with a low head.

Proposals for small-scale hydro use which have been supported by the program fall into two main categories:

1. development of the manufacturing and engineering capabilities needed to produce and install small-scale hydroelectric hardware;
2. testing of the existing small-scale hydro systems to detemine whether the systems are reliable and cost competitive.

Only eleven grant proposals for small-scale hydro projects have been received. Three of these were funded: one will attempt to develop a low-head hydroelectric system; another will use a 12 kilowatt system to supply the total power needs of an all-electric home; and the third will develop and test a high-head, hydroelectric system for use in fast flowing streams. These three projects were supported at a total amount of $58,935.

The preliminary results from the projects indicate considerable potential for small-scale hydro development. The high-head hydroelectric project, for instance, a 6 kilowatt (peak power) hydroelectric system, will have an estimated yearly output of 14,112 kilowatt hours. If there is sufficient head for the system, a water flow of 40 gallons per minute through a 2½ inch diameter pipe will supply the electrical needs of the average family, providing that electric space heating is not required.

The basis of this particular system is the Pelton wheel, a small, enclosed turbine which operates by direct pressure from a nozzle to a wheel composed of many small "buckets" (see photo). The power produced does not depend on the diameter of the wheel, but rather upon the head (or water pressure) and amount of water applied to it. The size of nozzle required is directly related to the pressure which in turn determines the wheel's rotational speed and electrical output.

This Pelton turbine is being used for small-scale hydroelectric development of fast-flowing streams. Water under high pressure is applied to the small "buckets", shown graphically in the photo, to turn the turbine and produce electricity and then piped back to the stream. The electricity can be stored in lead-acid batteries for later use.

Photo Courtesy Dave Kreider

A system of this type requires the construction of a small diversion dam across a stream. A pipe then carries water from the dam to a downstream power station, which need only be the size of a small tool shed. Located at any convenient point out of the reach of floods, the power station contains the generating equipment, battery storage and an inverter which changes the direct current produced to alternating current. Electrical energy produced by the system can be stored in lead-acid batteries, making unnecessary the storage normally supplied by a reservoir behind a dam.

This and other projects funded through the program develop and test systems that can be used under a variety of water flow conditions, helping to make small-scale hydroelectric generation feasible for people in many parts of Montana.

SOLAR

During the last three years, citizen interest in this renewable resource has mushroomed, attracting more program grant applications than any of the other renewable energy categories. Much of this interest is due to the extent of the solar resource, the need to develop solar applications for northern climates and the rapid development of commercial solar hardware.

When the program began, the biggest challenge was determining whether solar energy could be effective in Montana's cold northern climate. In order to adequately judge the feasibility of this energy source, the program has supported projects which:

1. research, develop or demonstrate as many of the different types of solar applications as possible;
2. obtain information regarding solar use in different locations in the state;
3. obtain Montana-specific data on the amount of solar radiation received throughout the state.

This attached solar greenhouse in Great Falls is an example of one of the most effective ways to use solar energy for heating an existing dwelling. The water filled 55-gallon barrels at right are painted green and collect and store solar energy for heating the greenhouse. Open windows leading into the living room on the left allows solar heat to enter the house for partial space heating.

Emphasis has also been placed on integrating solar with other renewable resources such as wind, wood and water, and on non-mechanical or passive solar use.

The diversity of projects supported through the program should lead to substantive data regarding solar use in Montana. The array of funded projects includes developing and testing of active and

passive components and subsystems, as well as installing, developing and testing the systems themselves. Twenty-five solar projects have focused upon the problems of retrofitting solar devices to existing structures. Other projects include developing and evaluating ways to provide effective backups to solar energy systems. While most projects are residential, a few involve commercial applications, such as one for domestic hot water heating of a retirement home and another for the design of a solar-heated school building.

The entire south side of this mobile home is covered with solar air collectors of sufficient size to supply complete space heating. Rock storage, located under the trailer pad, is completed first; the home is pulled over it and the necessary ducting is connected. When it is moved, the complete solar collector system and duct work remains with the trailer and the rock storage is then available for the next owner.

The performance characteristics of program-funded solar devices differ across the state. Some systems have not performed up to original expectations, principally because they were designed to work in other parts of the country, and there were insufficient data to specifically adapt them to Montana's climate. Much of this problem is being overcome through the program.

A central question to the acceptance of solar heating by the public and to its potentially broad use as an alternative source of energy is whether it is operationally and economically feasible. Besides solar component testing and research projects, the program is also supporting a project which will monitor a cross-section of the solar systems developed through the program. After the testing procedures have been evaluated and any necessary revisions made, the monitoring project will be expanded to include most of the solar projects funded. From the information gathered, the cost effectiveness and performance of these systems will be evaluated. This evaluation will be sufficiently standardized to permit comparisons with similar evaluations made in other parts of the country. It will then be possible to state accurately the conditions needed to effectively tap solar energy and provide key answers to the questions of economic feasibility and performance of solar systems in Montana.

WIND

The wind blowing across our eastern Montana prairie has long been recognized as a force to be reckoned with—often in terms of resisting its effect. Prior to the 1930's, the land was dotted with many small windmills which captured this ready power source for irrigation, stock pumps and household use. But when low-cost electricity became readily available, wind power lost favor.

Montana's winds vary considerably from calm periods to storms with winds exceeding 50 miles per hour. Designers of wind machines for this state must recognize the intermittent nature of the wind, make their devices strong enough to last through years of winter storms and yet be sensitive enough to make the most of light winds. Wind machines must overcome problems of icing, driving rain and temperatures ranging from -40°F to over 100°F. They must also be easy to maintain and have fail-safe controls. In addition, they must compete economically with other means of producing energy.

The approach in funding wind-related projects has been to encourage increased efficiency and lower costs in the future. Of the thirty-six grant applications received for wind projects, fourteen have been funded that:

1. research new designs and develop improvements in existing designs;
2. test different combinations of wind systems, storage devices and power outputs to improve component matching information;
3. develop accurate wind resource data within the state to aid in the siting and sizing of wind machines; and

4. explore the problems and prospects of integrating wind electric systems with existing utilities.

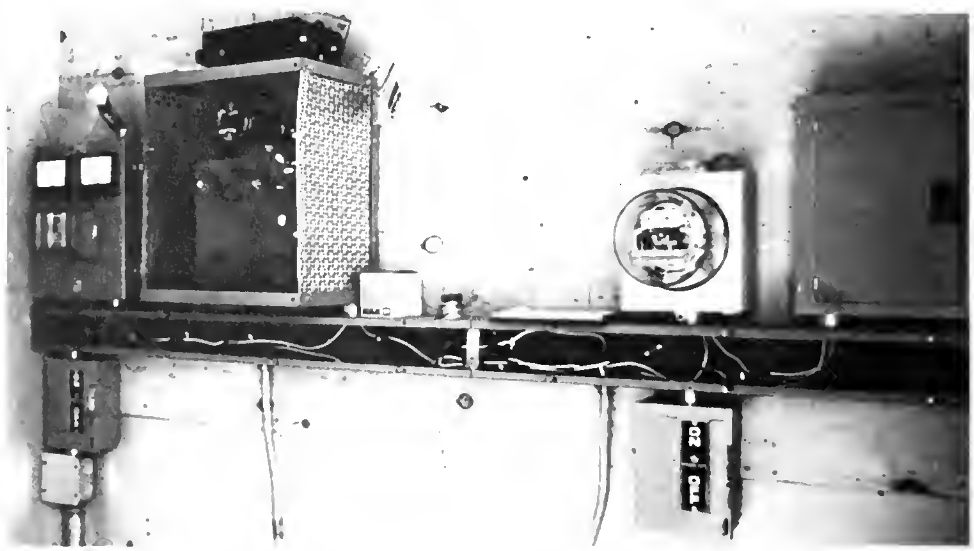
Most projects have been for development of domestic-sized wind systems. These projects include a wind generator made from used aviation parts, a homemade windmill that will be used to power an air compressor and a paddle wheel-type windmill, redesigned to increase efficiency.

In order to gather solid information on the actual output and dependability of any wind system, prototype systems designed for Montana's environment must be constructed and tested. One such system funded by the program centers on a wind-electric generator sized for large households or farm electricity requirements (24 kilowatt size). The project involves considerable research into blade designs that are easy to fabricate and suitable for assembly line production.

The system's fixed-pitch blade design and a rotor which positions itself downwind of the tower keep the design simple. A mechanical brake and a circuitry brake which uses electrical energy from the generator help regulate speed. Other controls built into the design allow the system to work under a wide range of wind conditions, broadening the research data obtained from operational tests. Monitoring of the prototype can provide important design information and help to develop other innovative systems for harnessing winds.

In addition to this type of project, the program is funding five wind monitoring projects designed to develop accurate wind resource data needed to determine potential wind power. The projects will involve monitoring of more than a dozen windy sites throughout Montana. All equipment purchased through these projects will be used later in other locations for continuation of the monitoring program.

This 2 kilowatt Dunlite wind electric system in Tracy is part of a research project exploring alternatives to storing excess energy produced by the machine. The equipment shown converts the direct current from the wind generator into alternating current, which can be fed into the utility power lines or used at the site.



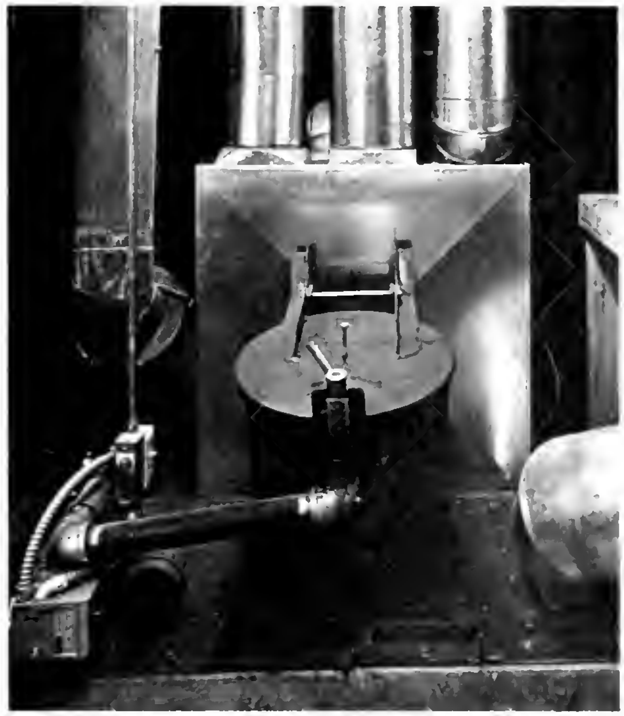
WOOD

Wood can be thought of as stored solar energy—released simply by burning. The availability of woody material and the recent rise in fossil fuel prices have prompted a stampede in purchases of fireplaces, stoves and other wood-burning devices. In many instances, however, little consideration is being given to the possible pollutant levels or efficiency of operations, since poorly designed wood-burning devices may sell as well as efficient, serviceable ones. Because wood can be effective as a renewable energy resource only if it is used carefully and efficiently, the program has funded projects in order to:

1. encourage innovative designs that will obtain more useable energy per pound of fuel while discharging fewer pollutants into the atmosphere; and
2. bring these innovative designs and uses within the economic reach of the average Montana homeowner.

Of the thirteen grant applications received for wood projects, seven have been supported at a funding total of $114,233. Wood projects developed through the program range in scope from a simple way of improving the effectiveness of an existing fireplace to the development of high-efficiency wood combustion systems. Many of the projects are revealing innovative ways to make better use of the heat content of wood and, in some instances, have actually been integrated into an existing central heating system for a dwelling.

The development of high-efficiency wood combustion systems offers considerable promise for the future. One program-funded project involves the development of a furnace with a double combustion chamber resulting in higher efficiency since the wood essentially goes through two burning operations. Other projects center on further development of wood boiler systems with water coils incorporated within a stove, fireplace or furnace. The water in the coils, heated when the wood is burned, is pumped into a hot water tank for storage. This water is then used for either domestic hot water or space heating, or both. In one instance, a high-efficiency wood boiler system has been developed in which the water heated from a single burning of the boiler can subsequently be stored in a large vessel and used to heat a home for a 2- to 3-day period. Some of these designs have been incorporated with other renewable energy sources as effective backup heating devices, providing an integrated, renewable energy system.



This pit-type furnace is an efficient wood combustion device developed through the program. Located in Noxon, it will burn logs 12 inches in diameter and 8 feet long. Since temperatures in the furnace can reach over 3,000°F, a single loading of the furnace is enough to heat the owner's shop complex throughout the day. An air-tight lid and small air intake valve insure that all wood and volatiles are burned.

In addition, the program has recently provided funds to create a wood testing facility in conjunction with the National Fireplace Institute and the Anaconda/Deer Lodge County government. The facility will test the thermal output of wood-burning fireplaces, furnaces and stoves, in an attempt to establish a rating standard for these devices. Currently, no standards are available to help the consumer compare the thermal efficiency of wood-burning units. Tests conducted at the facility will be used to develop operating performance standards by testing pollutant emissions as well as safety considerations. Testing will be done in accordance with test plans specified by the National Fireplace Institute.

EDUCATION/TECHNICAL ASSISTANCE

This area of program emphasis is the tie that binds all of the others together. To date, thirty-six applications for grants in this area have been received, and nine of them were awarded grant funds. Following is a general overview of the diverse projects that have received support.

EDUCATION

Successful education projects inform the public about the wide variety of renewable energy sources and how those sources can be used. The program was awarded grant funds for such educational projects as:

1. the Energy Use and Design course taught at Montana State Universty for engineers, architects and builders;
2. the energy/environmental simulator for a statewide energy education program which relates renewable energy to total energy use;
3. a study of the legal and institutional barriers to renewable energy development; and
4. the New Western Energy Show, a traveling theatrical troupe that has provided information on alternative energy through workshops, "hands-on" building experiences, drama and exhibits.

TECHNICAL ASSISTANCE

The program has contributed funds toward the purchase of an infrared scanner for use in testing solar system performance. Funds were also used to establish the Center for Innovation, where individuals desiring to further develop, test and market their renewable energy innovations can receive essential guidance and assistance. The center complements the Alternative Renewable Energy Sources Program by offering services that the program is not currently structured to provide but that are nevertheless necessary for furthering the development of renewable energy resources. The center assists with legal, technical, management, engineering and marketing support of renewable energy projects and will provide patent searches.

Photo courtesy of MSU

Dr. John Amend, inventor of the Energy/Environment Simulator, (left) stands by the first simulator model he developed. Last year, the simulator was demonstrated to 290 school and civic groups around the state. A similar model will be used by the Office of Public Instruction to stimulate discussion of energy production and use at high school workshops.

The equipment above is being used to process data obtained from electronic sensing equipment located in five of the program's solar heating systems. The resulting analysis will help evaluate system and component performance, an essential step to understanding why systems may or may not perform as expected.

PUBLIC INFORMATION

When applicants submit proposals for grant funds, they agree to share with the public all materials and information given to the Department. If the program is to offer the greatest benefit to the citizens of the state, the knowledge gained through the projects must become widely available.

The distribution of information to the public has been handled in a variety of ways. For example, when an applicant is awarded a grant, the local newspaper is notified and an invitation is extended to view the project during the course of its development. The grantee is also encouraged to hold open houses or tours of the project.

PUBLICATIONS

Prior to completion of any project, an abstract is developed. Included is the grantee's name and address, the amount of grant awarded, and a condensed version of the proposed project's scope and intent. These abstracts are published in the form of a booklet.

Once a project is completed, a synopsis is prepared outlining the scope of the work and its accomplishments. Referred to as a "Project Spotlight," these one-page publications (Appendix D) include project location, purpose, description, preliminary system performance, system modifica-

Photo Courtesy Dave Krelder

Solar heating systems were installed in both of these structures as part of a project by the Human Resources Development Council in Missoula. Five houses and ten mobile homes are being retrofitted with air collector systems; the mobile home systems do not use heat storage. An important result of this project has been to provide workmen with the training needed to construct and install the systems.

tions (if any), economic evaluation and viewing times. Also included are a detailed schematic and specifications for the system.

The Department will publish special reports on the research accomplishments of the program. Reports will also be prepared on the results from systems that have undergone sufficient monitoring and performance evaluation. Among the subjects being considered for special publications are:

1. design, performance and cost information on individual solar projects;
2. an index of the data being collected on the amount of solar energy received throughout Montana;
3. design detail and performance information on high-efficiency wood furnaces and stoves; and
4. a summary of information to be considered when selecting a solar system for use in Montana.

All reports and publications will be made available through libraries, university research centers, organizations working with alternative renewable energy and to the general public upon inquiry.

SLIDE SHOWS

Slide or video presentations will also provide information on renewable energy to the Montana public. A general slide show on the program with an accompanying cassette narrative has been prepared and copies are available for public use. Other such presentations will emphasize different renewable energy sources. Ideas under consideration for slide presentations include the installation of a small-scale hydroelectric system or wood furnace, and the different approaches to collecting and storing solar energy.

PUBLIC FORUMS

Beyond this, the grantees and the program staff regularly participate in meetings and workshops across the state. Many of the grantees have also become considerably involved with renewable energy outside of their projects. Several grantees, faced with large numbers of inquiries about their projects and renewable energy in general, have conducted special courses in their communities.

A series of owner-made solar air collectors in Glendive shows what can be done to retrofit an existing house for solar heating. The hot air travels through a 15-foot duct to the house and into the forced air furnace for space heating. Two of the panels are liquid solar collectors for pre-heating of domestic hot water.

SUMMARY AND EVALUATION

When the Alternative Renewable Energy Sources Program began with its first funding period in July, 1976, the use of renewable resources, except for large-scale hydro, to supply energy was considered a novelty. At that time, few states were developing renewable energy sources as an option to conventional fuels, even though an energy crisis had been declared and the prices of oil and natural gas were on the rise.

The response of the Montana Legislature was to enact Senate Bill 86 and begin the process of decreasing reliance on non-renewable energy sources. The wisdom of this action has been confirmed by responses from around the country and preliminary findings from a study by the Solar Energy Research Institute (SERI) on state-initiated, renewable energy incentives. The review by SERI states: "The Montana renewable energy grants program is one of the most progressive and noteworthy renewable energy programs initiated at the state government level, primarily due to its innovative and strongly committed approach."[1]

This 3-bedroom house just outside of Missoula uses solar air collectors for space heating. The hot air can be used directly from the collectors, or stored in a rock bin located under the greenhouse on the right.

[1] Solar Energy Research Institute, *"The Implementation of State Solar Incentives: A Preliminary Assessment,"* November, 1978.

[2] Alternative Renewable Energy Sources Act, Sec. 84-7407, R.C.M. 1947.

Much of the success of the program has been due to its method of funding. Because all grant proposals are unsolicited, applications have been submitted by groups and individuals from all parts of the state for any renewable energy project that will "...lessen...reliance on nonrenewable energy sources..."[2] In order to lessen that reliance, the technology developed through the program must be within the reach of all Montana citizens. Sponsors of the enabling legislation and the Department developed rules and guidelines for funding renewable projects with emphasis on applicability to practical home use. As a result, the program has been able to provide insight about renewable energy and its potential as an alternative to conventional fuels through funding a vast array of projects. These projects not only develop the technology by putting it to use, but also increase public awareness and knowledge through the experience of working with the technology.

The renewable energy sources being assessed by the program are biomass, geothermal, small-scale hydro, solar, wind and wood. Judging by the number of unsolicited proposals submitted to the program for solar projects (more than double the number submitted in all other renewable energy categories combined), this energy form is by far the most popular among the citizens of the state. More than 70 of the 124 projects initiated through the program have put this single energy source to use; many have incorporated solar with other renewable energy forms such as wind, water or wood in order to investigate integrated renewable energy systems. Preliminary results from these projects indicate that many different solar systems can have practical home application in Montana's cold climate. Examination is now being made of the cost effectiveness and performance of solar components and systems in order to provide key answers to the question of economic feasibility.

The program's solar projects exemplify the activity that is beginning to occur in the other renewable energy categories. Although technology development has been the most rapid in solar, projects funded in biomass, geothermal, small-scale hydro, wind and wood show promise of being effective energy sources. As may be expected in a program of this nature, a few projects may never become operational and some will prove to be ill designed. Nevertheless, even these projects are useful since, in the development of any new technology, knowledge is gained from the failures as well as the successes. From these experiences, renewable energy technology can appropriately evolve.

Montanans are beginning to witness the growth of renewable energy and the makings of a new industry. The interest in gasohol, the increasing number of solar manufacturers, distributors and retailers, and the growing demand for efficient wood burning devices, are examples. Results from the program's projects can provide answers to the question of economic feasibility—answers needed by the business industry, engineers, architects, lending institutions and the public if widespread use of renewable energy sources is to occur.

The renewable energy projects funded through the Montana program offer real promise and have allowed this state to quickly evolve in the area of renewable energy development. Nonetheless, the program must keep pace with the rapid and widescale development of renewable energy, and capitalize on the interest, knowledge and experience gained thus far. In addition, there must be a concerted effort to avoid duplication of the work being conducted elsewhere and to capitalize on it. The best way this can be accomplished is to develop a planned program approach for funding future projects and direct the program toward those areas requiring, but not receiving, adequate attention. With development and implementation of a comprehensive plan, the next step to lessening reliance on nonrenewable energy sources within Montana can be taken.

APPENDIX A

ADMINISTRATIVE COSTS BY FISCAL YEAR

BUDGET ITEM	FISCAL YEAR		
	1976	**1977**	**1978**
Personal Services	$29,461.68	$35,593.18	$46,853.14
Contracted Services	184.23	480.90	3,388.54
Supplies & Materials	111.73	161.99	325.17
Communications	3,991.98	266.32	1,372.22
Travel	489.87	1,866.99	4,099.61
Rent	7,500.00	4,408.92	6,302.39
Other Expenses	124.00	197.70	726.10
TOTAL	**$41,863.49**	**$42,976.00**	**$63,067.17**

APPENDIX B

GRANT REQUESTS RECEIVED AND AWARDED BY GRANT SUBMITTAL PERIOD

TABLE B-1

GRANT SUBMITTAL PERIOD ONE

1976

Energy Category	Number of Applications Received	Funds Requested	Number of Grants Awarded	Amount of Funding
Solar	61	$1,828,404	18	$215,136
Wind	11	218,924	4	81,495
Wood	4	87,209	2	5,000
Biomass	6	184,658	1	19,480
Geothermal	3	144,971	1	15,000
Hydro	3	156,327	1	19,885
Educational/Technical	5	319,441	2	$124,480
TOTALS	**93**	**$3,002,935**	**29**	**$480,477**

TABLE B-2

GRANT SUBMITTAL PERIOD TWO

January 1 to February 15, 1977

Energy Category	Number of Applications Received	Funds Requested	Number of Grants Awarded	Amount of Funding
Solar	83	$1,994,307	31	$346,061
Wind	10	244,755	5	60,550
Wood	4	10,105	3	10,405
Biomass	8	427,005	0	——
Geothermal	5	175,117	3	56,500
Hydro	3	162,182	1	25,000
Educational/Technical	13	644,051	2	65,806
TOTALS	**126**	**$3,677,523**	**45**	**$564,322**

TABLE B-3

GRANT SUBMITTAL PERIOD THREE

July 1 to August 15, 1977

Energy Category	Number of Applications Received	Funds Requested	Number of Grants Awarded	Amount of Funding
Solar	72	$1,941,611	18	$220,394
Wind	7	77,677	3	5,385
Wood	2	13,188	0	——
Biomass	3	169,349	3	80,717
Geothermal	1	2,000	1	2,000
Hydro	3	61,037	1	14,050
Educational/Technical	10	421,729	4	49,800
TOTALS	**98**	**$2,685,591**	**30**	**$372,346**

TABLE B-4

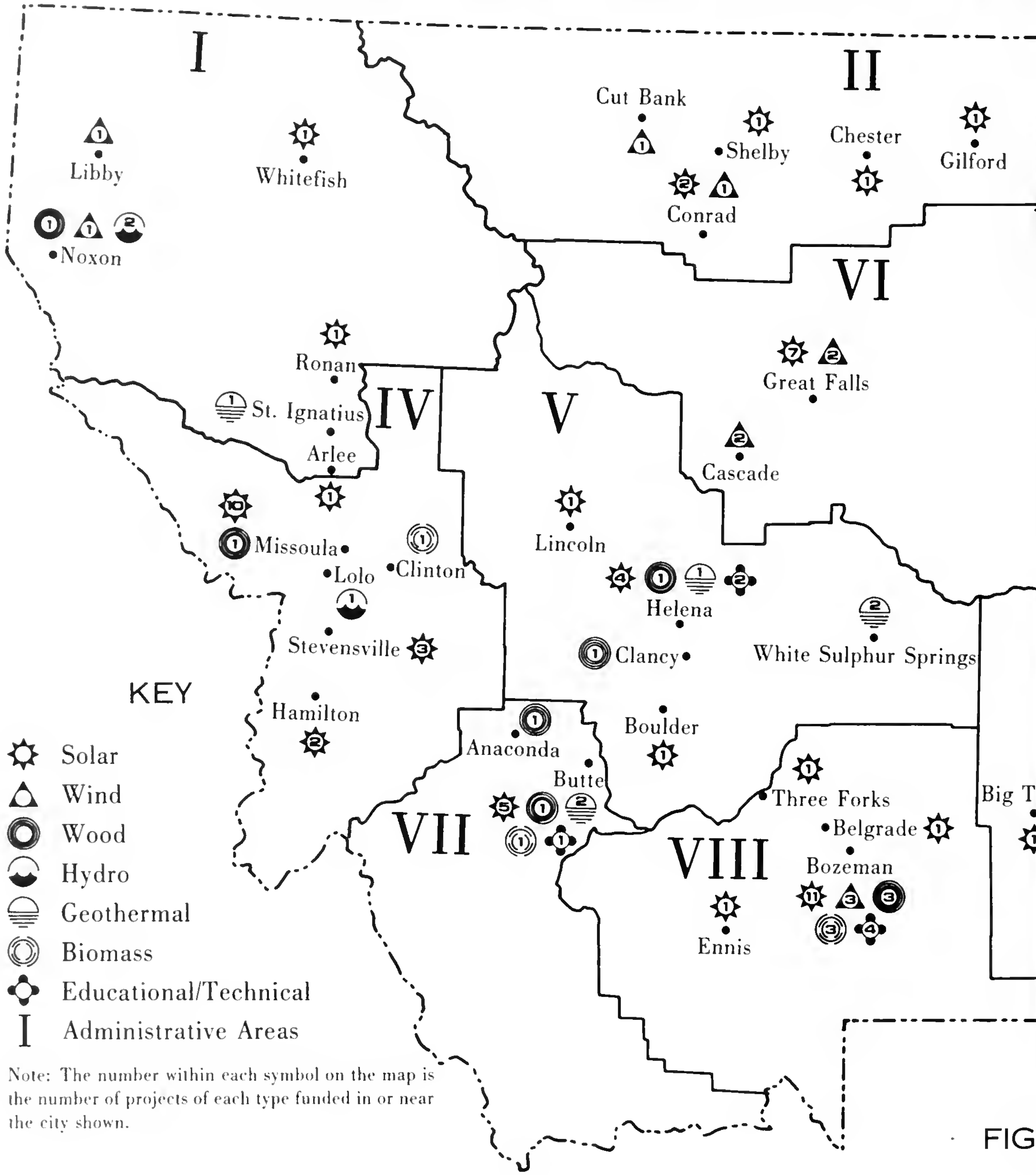
GRANT SUBMITTAL PERIOD FOUR

January 1 to February 15, 1978

Energy Category	Number of Applications Received	Funds Requested	Number of Grants Awarded	Amount of Funding
Solar	71	$ 1,230,559	11	$ 91,820
Wind	8	129,777	2	22,795
Wood	3	103,277	2	98,828
Biomass	2	50,624	2	29,064
Geothermal	6	91,415	1	10,265
Hydro	2	17,334	0	——
Educational/Technical	8	265,598	2	34,808
TOTALS	**100**	**$ 1,888,584**	**20**	**$ 286,808**
TOTALS OF ALL SUBMITTAL PERIODS TO DATE	**417**	**$11,255,632**	**124**	**$1,703,953**

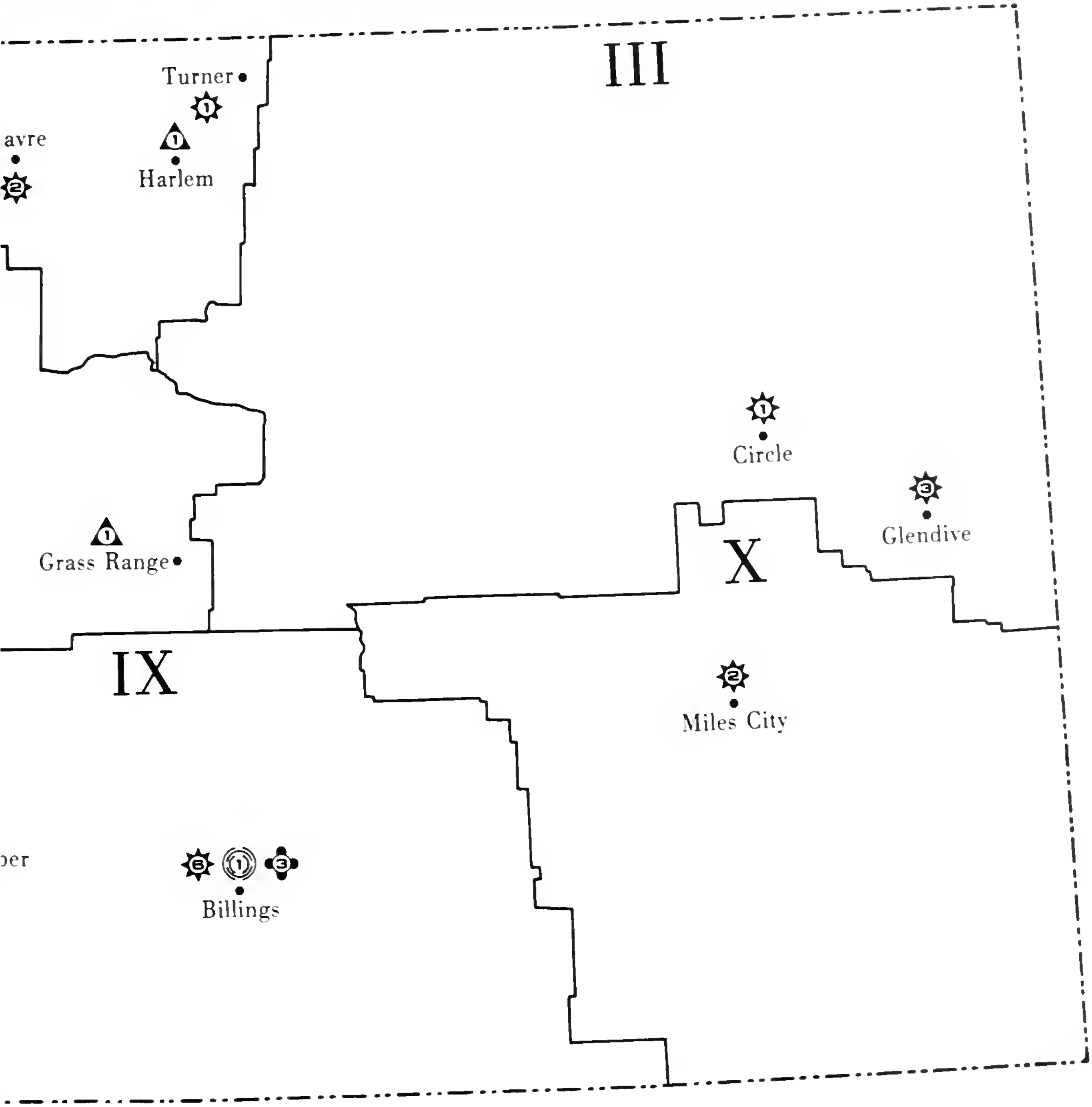
APPENDIX C

GEOGRAPHICAL DISTRIBUT



FIG

ON OF PROJECTS, 1976-78



RE C-1

GRANTEES AND THEIR PROJECTS

NOTE:

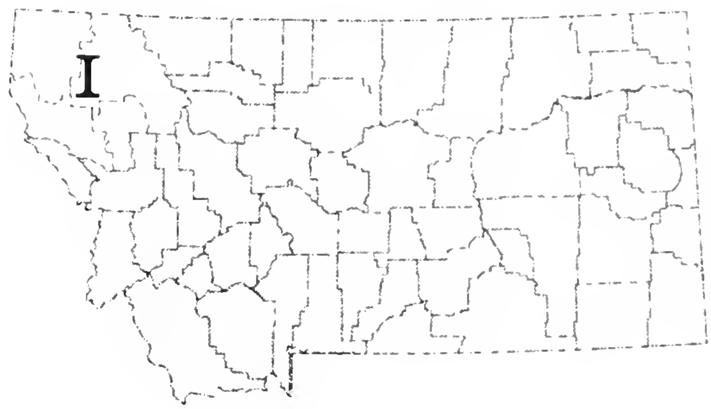
Unless otherwise indicated, all projects listed under SOLAR use liquid solar collectors in an active (mechanical), closed system. The amounts given refer to the total grant awarded, not necessarily the total cost of the project.

★ denotes a retrofit project.

AREA I

Lincoln
Flathead

Sanders
Lake



GEOTHERMAL

★ Dave Harriman Post Creek St. Ignatius, MT 59865	Geothermal Spring for Heat Pump System as Home & Greenhouse Heating	$4,000

SMALL-SCALE HYDRO

Bill Delp Independent Power Developers Box 1467 Noxon, MT 59853	Small Scale Hydroelectric Systems	$19,885
Bill Delp Independent Power Developers Box 1467 Noxon, MT 59853	Low Head, Low Impact Hydroelectric Systems	$25,000

SOLAR

Ronald Breese P.O. Box 221 Whitefish, MT 59937	Develop & Test 5 Tracking Parabolic Solar Collectors	$5,000

SOLAR COMBINATIONS

Phillip Schmitz Ronan, MT 59864	Solar Space Heating for Carpenter's Shop —Air Collectors With Wood Assist	$4,649

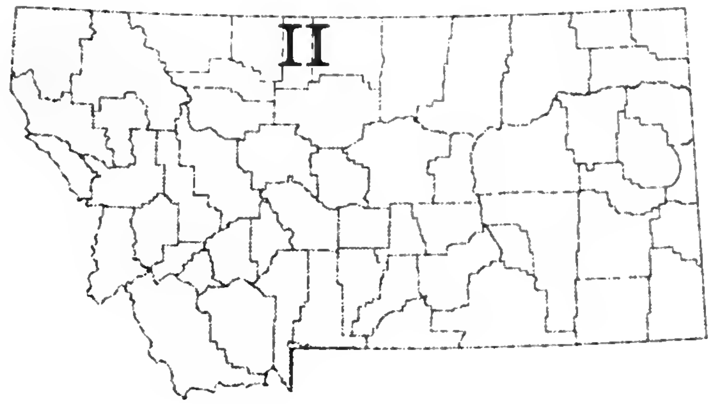
WIND

John Kelly Star Route Libby, MT 59923	Small Scale Wind Generation System	$3,500
Bill Delp Independent Power Developers Box 1467 Noxon, MT 59853	Domestic Sized Wind-Electric System	$64,256

WOOD

Bill Delp Independent Power Developers Box 1467 Noxon, MT 59853	Automatic High-Efficiency Wood Furnace	$6,968

AREA II



Glacier
Pondera
Toole

Liberty
Hill
Blaine

SOLAR

★ Horizon Lodge Major Caldwell 701 S. Wisconsin Conrad, MT 59425	Solar Hot Water System for Retirement Home	$79,013
★ Orville Oien C-E Ranch, Inc. Rural Route 3, Box 89 Conrad, MT 59425	Solar Space & Hot Water Heating	$7,276
J. Levi Hanson Box 1776 Gilford, MT 59525	Attached Solar Greenhouse for Passive Space Heating	$6,446
★ Dick King/Wayne Cross Dist. #4 Human Resources Council Box 1509 Havre, MT 59501	Solar Hot Air Collectors for 20 Low-Income Homes	$6,076
John Allemeier Havre, MT 59501	Solar Space and Hot Water Heating—Air Collectors	$6,309
City of Shelby Rae Kalbfleisch, Mayor P.O. Box 518 Shelby, MT 59474	Solar Heated Swimming Pool	$36,800
★ Otis Johnson Box 157 Turner, MT 59542	Solar Space Heating & Hot Water —Trickle Collectors	$3,000

SOLAR COMBINATION

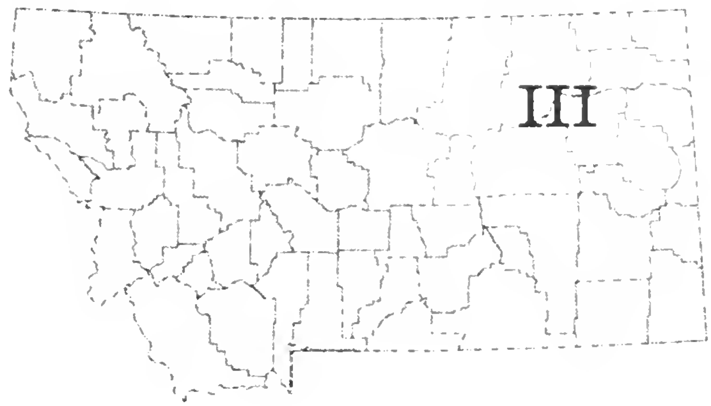
* Bruce McCallum P.O. Box 607 Chester, MT 59522	Attached Solar Greenhouse Using Liquid Collectors & Wood Stove for Heating —Also Wind Study	$3,159

WIND

David Kissner Route 3, Box 94A Conrad, MT 59425	Custom-Made Wind Generator	$5,500
LeRoy Gustafson Box 1168 Cut Bank, MT 59427	Paddlewheel-Type Windmill	$4,800
Ft. Belknap Agency Rural Route 1, Box 70 Harlem, MT 59526	Wind Monitoring on Reservation	$2,000

AREA III

Phillips
Valley
Daniels
Sheridan
Roosevelt
Petroleum
Garfield
McCone
Richland
Dawson
Wibaux



SOLAR

★ Dennis Howard River Road Glendive, MT 59330	Solar Space Heating —Air Collectors	$6,000
★ Stan Steadman 320 E. Power Glendive, MT 59330	Passive Solar Greenhouse	$1,240
★ Mike Stoltz 109 5th Highland Park Glendive, MT 59330	Solar Space Heating —Air Collectors	$3,805

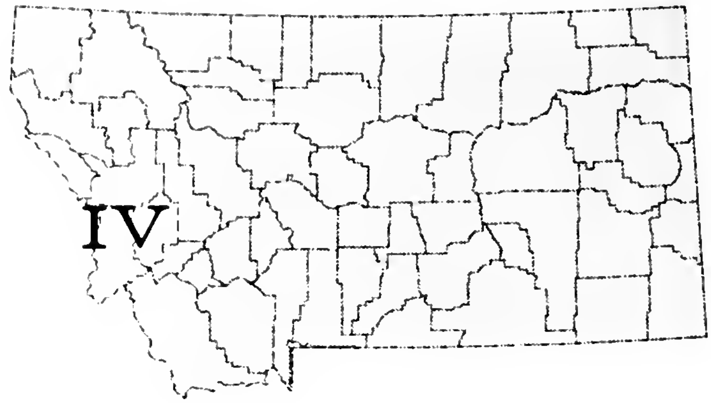
SOLAR COMBINATIONS

John Brown Box 216 Circle, MT 59215	"Energy" Self-Sufficient Solar Greenhouse	$12,500

AREA IV

Mineral
Missoula

Ravalli
Granite



BIOMASS

Jim and Doris Ekstrom P.O. Box 1010, Route 1 Clinton, MT 59825	Greenhouse Using Composting Heat Source	$3,144

SMALL-SCALE HYDRO

Terry Savage P.O. Box 26 Lolo, MT 59847	12KW Hydroelectric System	$14,050

SOLAR

City of Hamilton Ray Thrailkill, Mayor Box 709 Hamilton, MT 59840	Solar Municipal Swimming Pool	$38,320
Stephen & Gail Goheen Route 2, Box 2578 Hamilton, MT 59840	Solar Space Heating —Air Collectors	$5,680
Mike Barton Dist. #11 Human Resources Council 207 E. Main Missoula, MT 59801	Solar Domestic Hot Water Systems for Low-Income Homes	$15,000
Ken Boggs Dist. #11 Human Resources Council 207 E. Main Missoula, MT 59801	Low Cost Solar Heating Systems for Mobile Homes —Air Collectors	$26,000

Ken Boggs Dist. #11 Human Resources Council 207 E. Main Missoula, MT 59801	Solar Collector Systems for Low-Income Homes —Air Collectors	$26,875
John Means Route 5 Pattee Canyon Missoula, MT 59801	Solar Home Heating	$2,798 (see note)
John Means 1616 34th St. Missoula, MT 59801	Passive Solar Trombe Wall & Earth Sheltered Home	$8,600
Donald Peterson (Robert Heath) 1 Carriage Way Missoula, MT 59801	Solar Home Space & Hot Water Heating —Air Collectors	$7,000
Gail Owen 7001 Bitterroot Road Route 5 Missoula, MT 59801	Solar Space Heating —Air Collectors Solar Domestic Hot Water Heating —Liquid Collectors	$11,362
★ Richard Sheridan Botany Dept. University of Montana Missoula, MT 59801	Solar Collectors & Partitioned Storage	$8,000
★ John MacDonald Route 1, Box 53C Stevensville, MT 59870	Solar Space & Hot Water Heating for Home Using Water Heat	$4,314

SOLAR COMBINATIONS

★ John Fisher Jocko Hollow Alternative Energy Effort Arlee, MT 59821	Four Retrofit Solar Projects —Solar Greenhouse —Active Hot Water Heating System for Cabin —Drum Wall for Space Heating of Cabin —Solar Shower/Laundry Facility	$20,000
AERO-West Scott Sproull 323 W. Alder Missoula, MT 59801	Solar Heated Office/Renewable Library & Information Center	$6,498

NOTE:

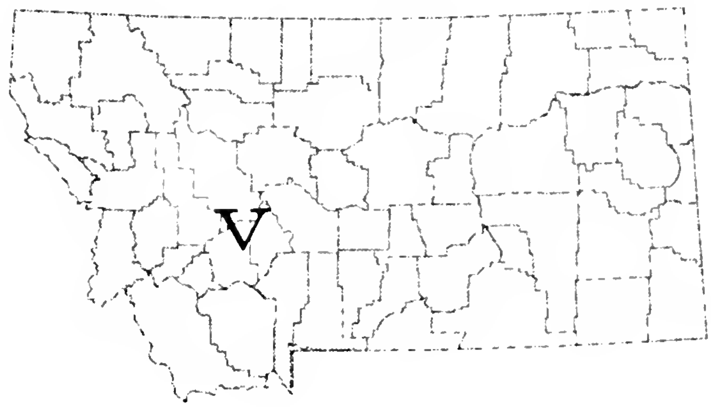
This project was destroyed in the Pattee Canyon fire. Means was originally granted $4,000 and returned the unused portion to the Department. The above figure reflects the amount spent on the project before its destruction.

John Duffield Route 5 Pattee Canyon Missoula, MT 59801	Passive Solar Trombe Wall With Wood Assist for Space & Hot Water Heating	$9,640
Anthony Terzo Route 4 Pittzville Missoula, MT 59801	Passive Solar With Wood for Space & Hot Water Heating	$10,000
Richard Dill Route 2, Box 50A Stevensville, MT 59870	Solar Space Heating & Development of High-Efficiency Wood Stove	$6,361
Tom Power Bass Creek Commune Route 2 Stevensville, MT 59870	Solar, Wind & Wood for Power & Space Heating of Home	$12,095

WOOD

John Badgley Institute of the Rockies 622 Evans Missoula, MT 59801	Feasibility Study for Underground-Wood Heated Conference Center	$3,675

AREA V



Powell
Lewis & Clark
Jefferson
Meagher

GEOTHERMAL

William Spilker Box 244 Helena, Mt 59601	Study & Model for Geothermal Energy Use in Subdivision	$15,000
Michael Grove First National Bank White Sulpher Springs, MT 59645	Geothermally Heated Bank	$43,500
Mountain Memorial Hospital John Bartos Box Q White Sulpher Springs, MT 59645	Drill & Test Well for Geothermal Potential	$2,000

SOLAR

Lowell Anderson 1311 University Helena, MT 59601	Development of Semicircular Hot Air Solar Collector	$4,000
David Orndoff 1063 Breckenridge Helena, MT 59601	Solar Space Heating	$5,000
Thomas Stewart 8945 Douglas Circle Helena, MT 59601	Research Into Covenants for Solar Subdivision Development	$3,000
James Taylor 2715 Airport Way Helena, MT 59601	Solar Space & Hot Water Heating —Air Collectors	$12,750

SOLAR COMBINATIONS

Phillip Pallister Jaybird Ranch Boulder, MT 59632	Solar Space & Hot Water Heating With Wood Assist	$8,000
Sherman Cook Lincoln, MT 59639	Solar Space Heating With Wood-Fired Boiler	$10,500

WOOD

* John Mason Lot 2-Block 7 Blue Sky Heights Clancy, MT 59634	Hippert Wood Furnace for Space Heating	$510
Leland Smith 2425 Chaparral Road Helena, MT 59601	Double Wood Stove Heating System	$2,837

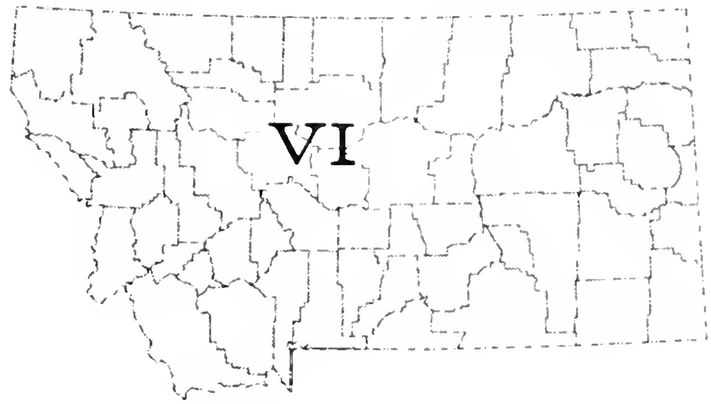
EDUCATIONAL—TECHNICAL ASSISTANCE

Richard Klinger 619 First St. Helena, MT 59601	Study Legal & Institutional Barriers to Renewable Energy	$10,000
Office of Public Instruction Ed Eshler Capitol Building Helena, MT 59601	Energy Environment Simulator for Statewide Energy Education Program	$3,000

AREA VI

Teton
Choteau
Cascade

Judith Basin
Fergus



SOLAR

★ Barbara Clowers 700 Seventh Ave. No. Great Falls, MT 59401	Solar Hot Water System	$2,800
★ William Kilby 3813 Fifth Ave. No. Great Falls, MT 59405	Solar Concentrating Collector System for Hot Water	$14,100
★ L. Clark MacDonald Bootlegger Trail Great Falls, MT 59401	Active & Passive Solar Collection for Space Heating	$8,743
★ William Tomlinson 403 Colorado Ave. N.W. Great Falls, MT 59401	Solar/Heat Pump Heating System	$7,166
Lawrence Truchot Route 2 South, Box 937 Great Falls, MT 59401	Solar Hot Water System —Trickle Collector	$7,500

SOLAR COMBINATIONS

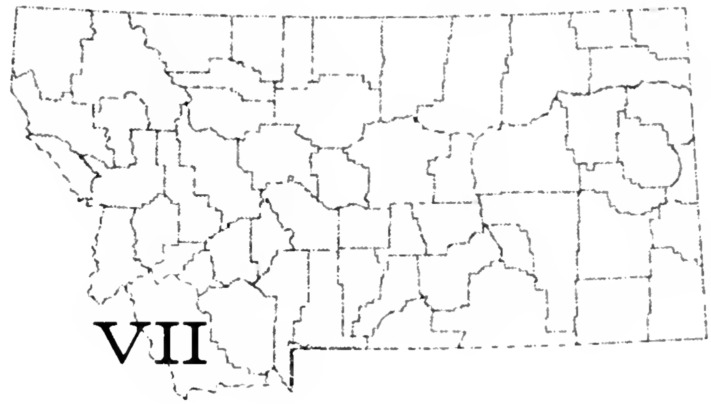
★ Gregory Cunniff 742-33 "B" Ave. N.E. Great Falls, MT 59404	Solar Space Heating With Wood Assist	$16,850
★ Gary Franklin 4428 Sixth Ave. So. Great Falls, MT 59401	Passive Solar Greenhouse With Wood Assist for Home Heating	$5,000

WIND

John Gordon Cascade, MT 59421	Wind Monitoring Near Cascade	$2,000
Wayne Lersbak, Supt. School Dist. #3 & 3B Cascade, MT 59421	Wind Monitoring	$10,000
Bill Stockton Grass Range, MT 59032	Home-Made Wind Powered Air Compressor	$1,385
Drapes Engineering 292 Eklund Great Falls, MT 59401	2KW Wind Generation System With Utility Interface	$19,375
Drapes Engineering 292 Eklund Great Falls, MT 59401	Wind Monitoring of Site (Tracy)	$5,000

AREA VII

Deer Lodge
Silverbow
Beaverhead



BIOMASS

National Center for Appropriate Technology John McBride P.O. Box 2828 Butte, MT 59701	Biogas Assessment	$25,264

GEOTHERMAL

Karen Barclay Montana Energy & MHD Research & Development Institute (MERDI) P.O. Box 3809 Butte, MT 59701	Conceptual Design for Geothermal Energy Use at Warm Springs State Hospital	$9,000
C. Wideman Montana Tech. Butte, MT 59701	Geothermal Development for Warm Springs Area	$10,265

SOLAR

Peter Antonioli P.O. Box 791 Butte, MT 59701	Development of Fluorescent Tube Solar Collector	$5,000
* Robert Corbett P.O. Box 3706 Butte, MT 59701	Passive Solar Heating Through Greenhouse for Space Heating Assist	$5,913
Charles Herndon/Nels Anderson Engineering Sciences Dept. Montana Tech. Butte, MT 59701	Solar/Heating for Office Space —Full Instrumentation & System Analysis	$16,000

Charles Herndon Engineering Sciences Dept. Montana Tech. Butte, MT 59701	Solar Heating Systems Evaluation	$15,000
Tom Shelley Montana Tech. Butte, MT 59701	Performance Testing of Solar Collectors & Working Fluids Systems	$14,812

WOOD

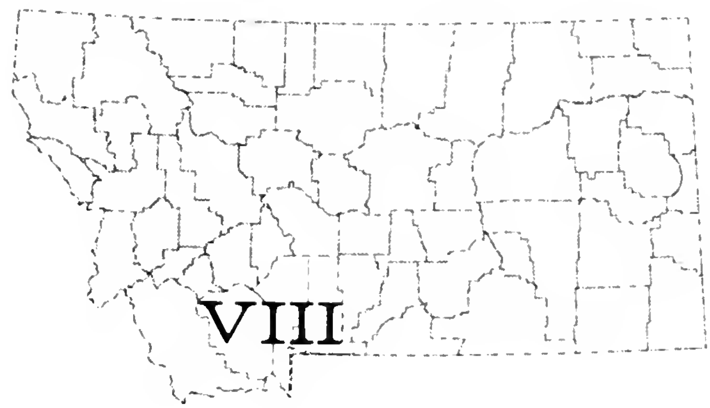
Anaconda-Deer Lodge County Government Joseph Wolf, City/County Mgr. Courthouse Anaconda, MT 59711	Testing Facility for Wood Stoves & Fireplaces	$98,318
Denny Driscoll Boys Home Rev. J.F. Finnegan P.O. Box 3093 Butte, MT 59701	Hippert Furnace for Boy's Home —Solar Air Collectors for Office	$30,000

EDUCATIONAL—TECHNICAL ASSISTANCE

Dr. Jerry Plunkett MERDI P.O. Box 3809 Butte, MT 59701	Center for Innovation	$100,000

AREA VIII

Madison
Gallatin
Park



BIOMASS

Don Brelsford Brelsford Engineering P.O. Box 1252 Bozeman, MT 59715	Feasibility Study of Producing Energy from Crops & Crop Residues	$25,000
John Robbins Chemistry Dept. Montana State University Bozeman, MT 59717	Biological, Biochemical & Chemical Engineering Techniques for Using Biomass as Energy Source	$19,480
John Robbins Chemistry Dept. Montana State University Bozeman, MT 59717	Bioconversion of Wastes—Increase Efficiency	$32,307
David Ward Microbiology Dept. Montana State University Bozeman, MT 59717	Survey of Biological Methane Production from Agricultural, Domestic & Industrial Sources	$23,410

SOLAR

Belgrade Public Schools Ralph Kroon, Supt. School Dist. #44 Belgrade, MT 59714	Feasibility & Pre-engineering Study for Solar Junior/Senior High School (Phase I)	$10,750
Belgrade Public Schools Ralph Kroon, Supt. School Dist. #44 Belgrade, MT 59714	Design Plan for Solar Junior/Senior High School (Phase II)	$1,500

Lee Barrett Electronics Research Lab Montana State University Bozeman, MT 59717	Solar Electric Radio Signal Repeater (Photovoltaic)	$5,314
John Drumheller Physics Dept. Montana State University Bozeman, MT 59717	Study of Natural Reflective Surface Efficiencies	$12,990
Fowlkes Engineering Charles Fowlkes 1820 S. Seventh Bozeman, MT 59715	Solar Space Heating & Storage Combination System for Mobile Home —Air Collectors	$25,000
Fowlkes Engineering Charles Fowlkes 1820 S. Seventh Bozeman, MT 59715	Detailed Monitoring of Installed Solar Systems for Efficiency & Economic Analysis	$30,000
Fowlkes Engineering Charles Fowlkes 1820 S. Seventh Bozeman, MT 59715	Solar Insolation Monitoring at 20 Locations —Education Program	$29,790
Peter Gobby 208 S. Willson Bozeman, MT 59717	Solar Heated Greenhouse for Winter Operation	$12,000
* David Levengood Bridger Canyon Route 2 Bozeman, MT 59715	Solar Space Heating —Air Collectors	$10,500
* Richard Lloyd-Jones Route 1 Ennis, MT 59729	Passive Solar Greenhouse for Home Space Heating Assist —Thermosiphon Liquid Collectors	$1,849
George Mattson 109 E. Main Bozeman, MT 59715	Solar Space Heating —Air Collectors	$8,000
* Ken Nordtvedt, Jr. Physics Dept. Montana State University Bozeman, MT 59717	Solar Heating of Domestic Hot Water for Apartment Complex Use	$4,000
James Orvis Route 1, Box 347 Bozeman, Mt 59715	Solar Mobile Home Heating	$3,700

SOLAR COMBINATIONS

Charles Fowkles 1820 S. Seventh Bozeman, MT 59715	Passive Solar Home With High-Efficiency Wood Furnace	$10,000
Jack Kreitinger Route 1, Box 195 Three Forks, MT 59752	Solar Space & Hot Water Heating With Wood Assist	$4,315

WIND

Brelsford Engineering Donald Brelsford P.O. Box 1252 Bozeman, MT 59715	Wind Survey of Livingston Area	$17,295
Robert Leo Electronics Research Lab Montana State University Bozeman, MT 59717	Small Scale Wind Generation System	$8,035
V. Hugo Schmidt Physics Dept. Montana State University Bozeman, MT 59717	Wind Energy/Synchronous Inverter	$7,346
V. Hugo Schmidt Physics Dept. Montana State University Bozeman, MT 59717	Continued Synchronous Inverter & Ducted Rotor Wind Generator Development	$19,640

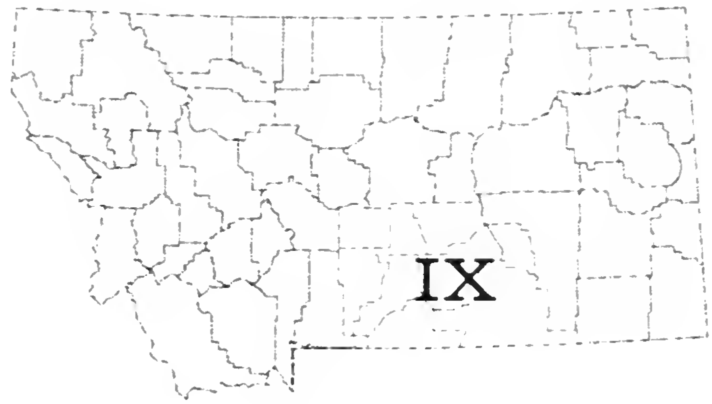
WOOD

Alvin Fiscus Route 3, Box 60 Bozeman, MT 59715	Monitor Wood Fireplace for Supplementary Home Heating	$600
S. Richard Hagan/Doug Polette Industrial Engineering Dept. Montana State University Bozeman, MT 59717	High-Efficiency Wood Furnace With Water Storage for Space Heating of Home	$4,000
★ Robert Zychek Route 1, Box 89A Bozeman, MT 59715	Wood Fireplace With Water Coils for Space Heating of Home Using Water Heat	$1,000

EDUCATIONAL—TECHNICAL ASSISTANCE

Thomas Reihman Mechanical Engineering Dept. Montana State University Bozeman, MT 59717	Purchase of Infrared Scanner —For Research by MSU —For Solar System Efficiency Testing by DNRC	$12,000
Donald Weaver, Jr. 2404 Spring Creek Dr. Bozeman, MT 59715	Develop a Digitized Heat Control & Energy Monitoring System	$6,000
John Charles/Robert Warrington Mechanical Engineering Dept. Montana State University Bozeman, MT 59717	Energy Use & Design Course for Contractors, Builders & Architects	$21,006
W. R. Martindale Mechanical Engineering Dept. Montana State University Bozeman, MT 59717	Conduct Energy Course as Seminar in 6 Montana Cities	$29,036
Robert Warrington Mechanical Engineering Dept. Montana State University Bozeman, MT 59717	Compile & Publish Handbook From Energy Use & Design Course	$5,000

AREA IX



Wheatland	**Yellowstone**
Golden Valley	**Treasure**
Musselshell	**Carbon**
Sweet Grass	**Big Horn**
Stillwater	

BIOMASS

Frank Groblebe Ida Lane Billings, MT 59101	Waste Heat Recovery from Compost	$7,173

SOLAR

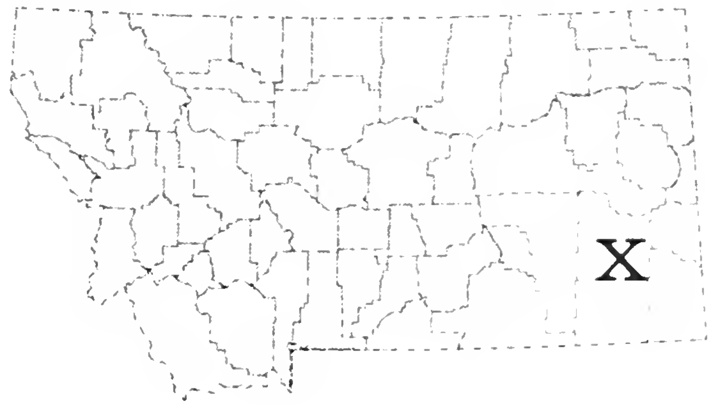
James Coons 208 N. 29th, Suite 212 Billings, MT 59101	Solar Space & Hot Water Heating	$11,000
★ Montana Conference of the United Church of Christ Rocky Mountain College Kimball Hall 1511 Poly Drive Billings, MT 59102	Solar Shower & Domestic Hot Water Heating for Summer Camp Site	$1,300
Phil Morrow Box 30214 Billings, MT 59107	Solar Space Heating —Concentrating Collectors	$12,500
★ Peter Rectfertig 1030 Harvard Billings, MT 59102	Passive Solar Space Heating	$1,265
John Wyckoff 4432 Phillip St. Billings, MT 59101	Passive Earth Sheltered Home With Active Liquid Solar Assist	$7,000
★ Norm Sulenes 2218 Fairview Place Billings, MT 59102	Passive Solar Heated Home —Freon Used in the Collectors	$10,760

John Alexander Box 426 McLeod Route Big Timber, MT 59011	Solar Space Heating —Air Collectors Hot Water Preheat Tank With Wood Assist	$10,972

EDUCATIONAL—TECHNICAL ASSISTANCE

Kye Cochran Alternative Energy Resource Organization (AERO) 435 Stapleton Bldg. Billings, MT 59101	New Western Energy Show	$24,480
Kye Cochran & Wilbur Wood AERO 435 Stapleton Bldg. Billings, MT 59101	New Western Energy Show	$44,800
Kye Cochran AERO 435 Stapleton Bldg. Billings, MT 59101	Energy Demonstraton Center for New Western Energy Show	$24,800

AREA X



Rosebud
Custer
Fallon
Powder River
Carter

SOLAR

Kurt Hughes 120 N. Custer Ave. Miles City, MT 59301	Passive Solar Home	$5,400
★ Max Leighty 2212 Bullard St. Miles City, MT 59301	Solar Space Heating —Air Collectors	$3,245

Renewable ENERGY project spotlight

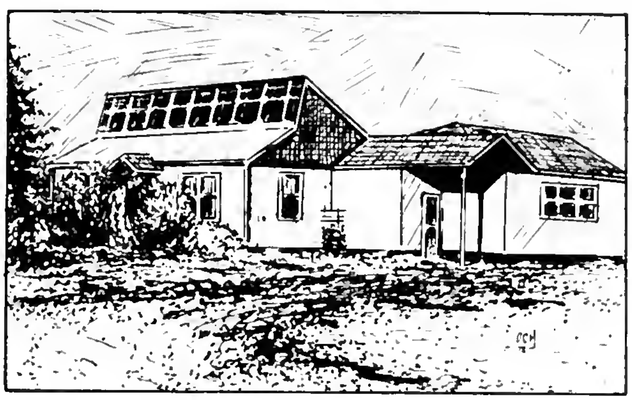
MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
RENEWABLE ENERGY PROGRAM
ENERGY PLANNING DIVISION 32 SOUTH EWING HELENA, MONTANA 59601 DNRC

Solar Space and Water Heating

LOCATION: Three miles west and north of Conrad, Montana on the C.E. Ranch, Incorporated.

PURPOSE: This retrofit project is designed to provide supplementary heat to a residence, and supply domestic water heating. It also demonstrates that the use of a system of reflectors substantially increases the efficiency of a minimal number of solar collectors, and that a satisfactory and reliable heat storage system can be added to an existing house without major structural changes.

PROJECT: The solar collector design was adapted to local weather conditions — strong winds, extreme cold and hail, all of which could damage the collectors or reduce their efficiency. The essence of the design was the housing of the collector array within a south-facing shed, positioned upon the home's roof. The 96 square feet of liquid collectors (tube-on-plate absorbers by Olin Brass) were mounted at a 63 degree angle on the south-facing roof and were protected by double-glazed patio door glass, bought as salvage for less than $125. The shed was built over the collectors by extending the north-sloping roof past the roof peak and over them. The inside of the shed was lined with reflective aluminum sheets, and aluminum-faced shutters lie in the roof in front of the collectors. The shutters can be closed to protect the collectors or prevent heat loss. Altogether there are 450 square feet of reflective surface. The ethylene glycol and water from the collectors passes through coiled copper tubing to transfer heat to fourteen 120-gallon water storage tanks (glass lined). A Deko-Labs Model TC-3 differential thermostat switches the collector pump "on" when the collector temperature exceeds the storage water temperature by a predetermined temperature difference. The thermostat also switches the pump "off" if the collector cools or the storage temperature increases so there is only a 5 degree F. temperature difference.



A number of small tanks were used in order to avoid the problems associated with installing a single large tank in an existing structure. In addition, by simply turning a few valves, it is possible to improve system efficiency by reducing the storage to a size which is more appropriate to the amount of heat delivered by the collectors. When space heat is required for the home, water is circulated from the storage tanks to a water-to-air heat exchanger located in the cold air plenum of the forced air furnace. The stored heat is thus circulated throughout the home by the conventional heating system. The heat transfer mechanism for the domestic water system is somewhat different. In order to avoid contamination of the domestic water supply by the ethylene glycol, the separate 40-gallon preheating tank has the tubing circling it on the outside. This arrangement decreases the efficiency of the preheating tank slightly.

SYSTEM PERFORMANCE: Once installed, the collector system worked well, even though it operated for nearly five weeks without the reflectors. Interestingly, late arrival of material for the reflector system provided a chance to verify one important aspect of the system. Once the reflectors were installed, it was found that even though the hours of sunlight were shorter, collection time was longer. During the day in which the reflectors were installed, the system collected heat for 7.8 hours — the longest time in over a month.

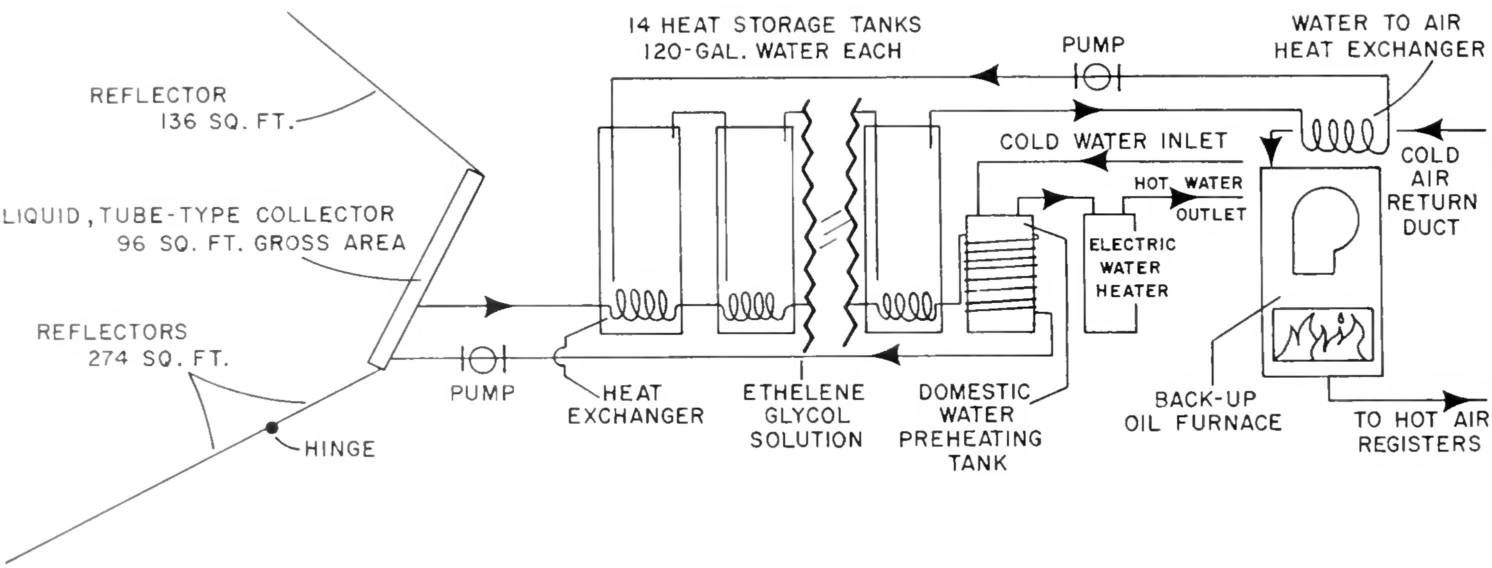
The shed operates as planned, and protects the collectors from snow and wind. On clear days during December, 1977, operation times were often 6.5 hours or more. Daily operation averaged about 3.5 hours per day from October 20, 1977 to January 14, 1978, the period of the year having least sunshine at this latitude.

MODIFICATION: The heat exchange systems had originally been planned to transfer heat from the water storage tanks to the cold air plenum of the oil-burning furnace. However, even though the room housing the tanks was well insulated, it was found that considerable stored heat was being lost there. The owner decided that the resultant heat loss could be corrected by eliminating the heat exchanger in the cold air plenum and moving the storage tanks to a different part of the home. Placing the tanks into a special crawlspace which is insulated on the outside and venting the warmed air directly into the living space, (using the passive principle of convection), will greatly improve system efficiency. Since the tanks act as radiators, no plumbing into a circulating system is needed, so additional labor and material costs can be avoided.

Another advantage of eliminating the heat exchanger is that a lower grade of heat is usable. The water for the heat exchanger has to be at least 100 degrees F. in order to transfer a significant amount of heat from the water to the air forced through the cold air plenum. By using the warm storage room air, stored heat as cool as 70 degrees F. can be used to bring the living space temperature to 65 degrees. There is no time lag in heat transfer because the transfer is direct, and the use of convection does not require fans to move the warmed air, since warm air naturally rises.

ECONOMIC EVALUATION: Initial system cost was $7,987.21, of which $7,276 was covered by grant funds. For 96 square feet of collector, the system cost was $83.20 per square foot, but including the area added by the reflectors the price would be ½ to ⅓ this figure, as low as $37.73 per square foot. Projected annual savings on space/water heating were expected to be $230 for the first year of operation. Rising fuel oil prices will increase savings realized with solar heat. The payoff period estimated by the owners is twenty years for an investment of $8,000. Further evaluations of the system will help verify and give greater definition to this information.

VIEWING TIMES: The project can be seen during the day on the first Sunday and Monday of each month or by appointment. Call 278-3355 or write Orville Oien, RR3, Box 89, Conrad, MT 59425.



HOUSE	
General:	Existing single family dwelling, forced air oil-burning furnace
Floor area:	1550 square feet
Calculated heat loss:	11,575 BTU's per Degree Day plus domestic hot water heat load
COLLECTOR	
Transfer fluid:	50-50 mixture, ethylene glycol and water
Tilt:	63 degrees from horizontal
Orientation:	True south, on roof of house
Size:	98 square feet gross surface area, plus 450 square feet reflective surface
Circulation rate:	4 gpm (2.45 gph per square foot of collector)
Construction:	Thermopane patio door glazing; tube-in-plate Roll-Bond absorber by Olin Brass; insulation and plywood back. Reflectors: delta-rib, aluminum roofing
STORAGE	
Medium:	Water, 1680 gallons
Container:	120 gallon tanks, wrapped with 6 inches fibreglass insulation
Relation to collector:	17 gallons per square foot of collector area

APPENDIX E

ALTERNATIVE RENEWABLE ENERGY SOURCES PROGRAM RULES

Sub-Chapter 18

Alternative Renewable Energy Source Grants

36-2.8(18)-S8060 PURPOSE OF RULES

Senate Bill 86 enacted by the 1975 Legislature provides for the funding through the Department for research, development and demonstration of alternative renewable energy sources. The purpose of the rules in this sub-chapter is to provide criteria and guidelines to aid in the implementation of that law.

36-2.8(18)-S8070 DEFINITIONS

Unless the context requires otherwise, as used in the act and in the rules in this sub-chapter:

(1) "Act" means Chapter No. 501, Montana Session Laws of 1975 (also referred to as the "Alternative Renewable Energy Sources Act"; Section 84-7407 et seq., R.C.M. 1947).

(2) "Alternative renewable energy source", as defined in Section 84-7408(1) of the Act, means a form of energy or matter, such as solar energy, wind energy, or methane from solid waste, capable of being converted into forms of energy useful to mankind, and the technology necessary to make this conversion, when the source is not exhaustible in terms of this planet and when the source or the technology are not in general commercial use.

(3) "Person" means a natural person, corporation, partnership, or other business entity, association, trust, foundation, any educational or scientific institution, or any governmental unit.

(4) "Department" means the Department of Natural Resources and Conservation.

(5) "Application" means a written application to the Department for funding under the terms of the Act and these rules.

(6) "Research" means an extensive, systematic study to discover or revise facts or theories and which would bring to more advanced state the capabilities, availability and suitability of a renewable alternative energy source.

(7) "Develop" or "development" means a project which utilizes the basic results of research or available knowledge and applies those results or knowledge to the actual development of hardware. The term also includes the establishment of manufacturing facilities to produce renewable alternative energy systems in Montana, but it does not include the development of a project or facility to commercially market electricity, heat energy, or energy by-products.

(8) "Demonstrate" or "demonstration" means an extensive, systematic plan and follow-through to establish that specific renewable alternative energy sources are practical and can be made to work reliably over long periods of time. These projects are primarily physical models which will be proven.

36-2.8(18)-S8080 STATEMENT OF ADMINISTRATIVE POLICIES

(1) It is the objective of the Department to orient the funding program toward the small scale, individual, single unit dwelling type of application. Large scale, capital intensive project applications will be accepted, but the program emphasis will be directed toward the aforementioned type of application.

(2) It is the objective of the Department to give funding preference to development and demonstration projects.

(3) It is the intent of the Department to grant funding only for applications which are submitted by persons who are residents of the state of Montana, and only for projects conducted in Montana. "Conducted" means that the research and development project will be headquartered in Montana and that all development will be built in Montana. This condition does not prohibit the use of expertise outside the State of Montana.

(4) Persons who are employees or contractors of the Department, or who are members of the Board of Natural Resources and Conservation, are not eligible for funding under the Act. Relatives related to such person by consanguinity within the fourth degree or by affinity within the second degree are likewise not eligible for funding.

(5) Applications to research, develop, or demonstrate geothermal energy sources on a small scale will be considered for funding. Large scale, capital intensive projects are not eligible for funding.

(6) Some types of renewable alternative energy sources (e.g., solar and wind) are unable to produce energy on a continuous basis, therefore applications for studying energy storage devices associated with such renewable energy sources, will be accepted.

(7) As a general rule applications for more than $100,000 will not be granted. However, the Department will accept and review applications for more than $100,000. If the Department determines that such a proposal is particularly applicable to Montana's energy needs and technically outstanding, it may be funded. There is no lower limit for funding.

(8) The Department will appoint an Alternative Energy Advisory Council (AEAC) consisting of five members who will make recommendations on which applications should be funded. The Department makes the final decision as to which applicants are funded.

(9) Applications shall be applicable to Montana's energy needs. If the technology is not feasible as suited to the needs of Montana, the application will not be granted.

(10) The Department may fund all or only part of a proposal. Generally, only an application which is directly related to the research, development, or demonstration of alternative renewable energy sources will be funded. For example, an application to build a $50,000 solar home may not be funded in full, but an application to demonstrate new solar technology as part of a home may be funded.

36-2.8(18)-S8090 APPLICATIONS — GENERAL REQUIREMENTS

(1) Any person may make application for a grant to fund a proposal under the Act and these rules. The applicant should normally submit ten copies of the application at the time of filing to the Energy Planning Division of the Department, 32 South Ewing, Helena, Montana, 59601, consistent with these rules. A lesser number of copies may be submitted upon prior approval of the Department.

(2) Although not required, to facilitate uniformity the application should meet the following requirements:

(a) The application should be typed, printed, or otherwise legibly reproduced on 8½ x 11" paper. Maps, drawings, charts, or other documents bound in an application should be cut or folded to 8½ x 11" size. Maps, drawings, or charts may accompany an application as separate exhibits.

(b) Typed or offset material should have a 1" margin on all sides.

(c) All pages in an application should be consecutively numbered. Maps, drawings, or charts accompanying the application as exhibits should be identified as "Exhibit __________," and if comprising more than one sheet should be numbered "sheet __________ of __________."

(3) (a) The application shall state the name, title, telephone number, and post office address of the person to whom communication in regard to the application should be made.

(b) The application shall contain a statement agreeing that all material submitted by the applicant to the Department is subject to public scrutiny.

(4) The Department will review the application to determine whether it is in substantial compliance with the Act and these rules. If the Department determines that the application is not in substantial compliance with the Act and these rules, the application will be considered deficient and the Department will reject the application, notifying the applicant in writing and listing the application deficiencies. The application may be re-submitted after corrections are made.

(5) The applicant should submit supplemental material upon request or when it becomes available without undue delay after an application is filed to update drawings and information submitted with the original application.

(6) If an applicant desires to change or add to an application, after it is formally filed, the applicant shall inform the Department in writing as soon as possible of the change or addition. If the change or addition will result in a substantial change in the amount of funding requested or the goals and objectives stated in the original application, the Department will consider the change or addition to constitute a new application.

(7) There is no form adopted by the Department to fill out in making an application.

36-2.8(18)-S8100 APPLICATION CONTENT

(1) An application shall include a general declaratory statement indicating whether the applicant is seeking funds for a research, development, or demonstration project.

(2) The application shall include a declaration of the type of renewable alternative energy sources to be studied (i.e., wind, solar, water, etc.).

(3) The application should contain a review of the existing "state of the art" conducted by the applicant in the area of interest.

(4) The application should include, whenever applicable, a description of the proposal, including, but not limited to:

(a) A theoretical basis for the proposal including all pertinent maps, diagrams, and photographs;

(b) The proposed technology including all pertinent diagrams and photographs;

(c) The proposed research methods and construction methods if construction is a factor, plus all pertinent maps, diagrams and photographs;

(d) The proposed facilities and equipment needed, including physical dimensions, diagrams, and photographs;

(e) The proposed time schedule for project development;

(f) A description of the proposed anticipated results, both practical and theoretical;

(g) A statement as to how the project can advance the state of the art;

(h) A statement indicating where the project will be constructed, and why that particular site is suited to the proposed project;

(i) A statement indicating who will work on the project, and what their various qualifications are;

(j) A statement of the role of the project in meeting future energy needs;

(k) A statement of how the project will be feasible and applicable;

(l) A statement of the project's environmental compatibility, especially:

(i) Pollutants or contaminants produced;

(ii) An estimate of the net energy yield of the project.

(5) The application shall include an estimated maximum budget which may not be exceeded, which should contain:

(a) The wages and salaries of all research personnel, clerical help, craftsmen, etc. (itemized);

(b) A list of employee benefits;

(c) A list of building costs;

(d) A list of equipment costs (equipment generally are permanent items);

(e) A list of administrative and overhead costs;

(f) A list of the cost of supplies (supplies generally are exhaustible items);

(g) A list of communication and travel costs;

(h) A list of any other expenses.

(6) The application should contain a copy of all contracted or sub-contracted work, including budgets, who is to do the work, and what work is to be done. If these are not available at the time of application, they shall be submitted at the time they become available.

36-2.8(18)-S8110 APPLICATION SUBMITTAL DEADLINES

Applications shall be submitted from January 1 through February 15 and from July 1 through August 15.

36-2.8(18)-S8120 APPLICATION EVALUATION

(1) In general, applications will be reviewed and evaluated by members of an adhoc committee which will be established by the Department. These members will be qualified technical people in their respective renewable alternative energy fields. They may or may not be residents of the state of Montana. The evaluations will be done on an anonymous and confidential basis and the results will be disclosed to the applicant upon request.

(2) The Alternative Energy Advisory Council (AEAC) will meet to discuss the reviews and evaluations of each application and make recommendations to the Department.

(3) Due to the finite amount of funds available during each evaluation and grant period, applications received for consideration at that time will be compared for relative merit as well as individual merit. The Department will then decide which applications to fund.

36-2.8(18)-S8130 AWARDING GRANTS — CRITERIA

(1) A grant awarded by the Department may cover a period not exceeding one (1) year, and the Department may not by law commit itself to spending funds anticipated to be available more than one (1) year after the grant period begins. The Department may, however, issue letters of intent to renew projects which require more than one year for completion if in the opinion of the Department, the first year of work is successful and achieves the goals established by the original application. Applications for renewal will be evaluated in the normal evaluation manner and must compete with new applications for funding.

(2) The Department may give preference to research centers unattached to existing educational institutions where several investigators can share supporting services. However, this shall not be interpreted to prohibit the Department from awarding grants to existing educational institutions or individuals.

(3) If a manufacturing project defined under the development type of application is successful, the applicant may be required to repay the Department all or part of the funds granted.

(4) By law, all information resulting from research, development, or demonstration projects funded by the Department under the Act and these rules shall be made available to the public and may not become the private property of or under the exclusive control of any one company or person.

(5) The Department is under no requirement to expend or commit available alternative renewable energy research, development and demonstration funds when in its judgment such expenditures or commitments would he unproductive.

36-2.8(18)-S8140 CONDITIONS UNDER WHICH GRANTS MAY BE USED AND OTHER CONDITIONS

(1) Applicants shall enter into a contract grant agreement with the Department if funded, under such terms and conditions the Department considers appropriate. If the recipient feels that changes in the contract are necessary at some later date, then those changes shall be negotiated with the Department. If a satisfactory agreement cannot be reached, the contract and the funding may be terminated by the Department.

(2) Grant recipients shall submit periodic progress reports as specified by the Department, and shall submit final reports to the Department within three (3) months following the yearly grant period.

(3) Grant recipients shall submit an itemized list of expenses with each monthly or quarterly billing for payment.

(4) Grant recipients shall make oral or written presentations of progress if requested to do so by the Department.

(5) Funds granted under the terms of the Act and these rules may be used only for the purposes outlined and described in the application and approved by the Department, and detailed records shall be kept by the recipient for all expenditures. Since the proposal budgets are initially estimated, some transfers up to 25% among the budget categories expenditures will be allowed.

(6) The grant recipient shall maintain an accounting system which adequately accounts for expenditures in a manner acceptable to the Department. Records, expenditures, bookkeeping, etc. for funded projects are subject to audit by the Office of the Legislative Auditor and the Department.

(7) Arrangements shall be made to assist, guide, and inform the Department during on-site investigations. The Department will make such investigations at its discretion.

36-2.8(18)-S8150 PAYMENT OF GRANTS

(1) Upon approval of an application by the Department, funds will be set aside for that particular project.

(2) Payments shall be made on a monthly or quarterly basis against the balance of a given application's funds, upon a request for payment by the recipient.

(3) Payments will be made only on valid project related expenditures, and any balance of payment made at the end of the one year's funding period shall be returned to the Department.

36-2.8(18)-S8160 PROJECT ADMINISTRATION

(1) The results of all research, development or demonstration projects shall be made public record.

(2) Persons receiving demonstration funds may be required to make their projects open to the public during reasonable hours for a period of time specified by the Department.

(3) The Department may inspect and monitor all projects on a regular basis after completion of the project.

(4) The applicant may be required to maintain his funded project during the monitoring period.

36-2.8(18)-S8170 CONFIDENTIALITY

Upon submitting an application to the Department pursuant to Rules 36-2.8(18)-S8160 through 36-2.8(18)-S8170 the application becomes a government document subject to public scrutiny. The applicant waives any claim of confidentiality by filing an application with the Department.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC

ENERGY DIVISION 32 SOUTH EWING HELENA, MONTANA 59601